CLAIMS

What is claimed is:

1. A water treatment system for reducing the concentration of arsenic in water below an acceptable level, comprising:

    means for adding magnesium hydroxide to the water;

    means for adsorbing arsenic on the magnesium hydroxide; and

    means for separating and removing from the water the magnesium hydroxide with adsorbed arsenic, thereby reducing the concentration of arsenic in the water to below the acceptable level;

    wherein the magnesium hydroxide has a median particle size less than 3 microns.

2. The system of claim 1, wherein adding magnesium hydroxide to the water comprises adding magnesium oxide, which converts to magnesium hydroxide upon contact with the water.

3. The system of claim 2, wherein the magnesium oxide comprises reactive magnesium oxide.

4. The system of claim 1, wherein the means for adsorbing arsenic on the magnesium hydroxide comprises means for mixing the magnesium hydroxide with the water.

5. The system of claim 4, wherein the means for mixing the magnesium hydroxide with the water comprises an apparatus selected from the group consisting of means for stirring and means for shaking.

6. The system of claim 1, wherein the means for adsorbing arsenic on the magnesium hydroxide comprises a holding tank to provide sufficient time for magnesium hydroxide to adsorb a sufficient amount of arsenic to reduce the concentration of arsenic in water below the acceptable level.

7. The system of claim 1, wherein a sufficient amount of magnesium hydroxide is added to the water to reduce the concentration of arsenic to below an acceptable level of 10 ppb.

8. The system of claim 7, wherein a sufficient amount of magnesium hydroxide is added to the water to reduce the concentration of arsenic to below an acceptable level of 2 ppb.

9. The system of claim 1, wherein the water comprises wastewater from an industrial process.

10. The system of claim 1, wherein the water comprises potable water.

11. The system of claim 1, wherein the magnesium hydroxide is used in a form selected from the group consisting of a suspension, a slurry, a powder, and a particulate.

12. The system of claim 1, wherein the magnesium hydroxide has a median particle size of 0.5-1 microns.

13. The system of claim 1, wherein the magnesium hydroxide is used in the form of a powder having a surface area of 7-13 m^2/gram.

14. The system of claim 1, wherein the means for adsorbing arsenic on the magnesium hydroxide comprises means for maintaining the magnesium hydroxide in contact with the arsenic contaminated water for less than approximately one hour.

15. The system of claim 14, wherein the magnesium hydroxide is maintained in contact with the arsenic contaminated water for less than approximately thirty minutes.

16. The system of claim 15, wherein the magnesium hydroxide is maintained in contact with the arsenic contaminated water for less than approximately 2 minutes.

17. The system of claim 1, wherein the step of adsorbing arsenic on the magnesium hydroxide comprises stirring the mixture of water and magnesium hydroxide to keep the magnesium hydroxide in suspension for a period of time sufficient to adsorb an amount of arsenic sufficient to reduce the concentration of arsenic in the water to below the acceptable level.

18. The system of claim 2, wherein adding magnesium hydroxide to the water comprises adding 0.001-10 grams of MgO to each liter of water to be treated.

19. The system of claim 1, wherein adding magnesium hydroxide to the water comprises adding 0.001-10 grams of $Mg(OH)_2$ to each liter of water to be treated.

20. The system of claim 18, wherein adding magnesium hydroxide to the water comprises adding 0.1-0.5 grams of MgO to each liter of water to be treated.

21. The system of claim 19, wherein adding magnesium hydroxide to the water comprises adding 0.1-0.5 grams of $Mg(OH)_2$ to each liter of water to be treated.

22. The system of claim 1 wherein the means for adsorbing arsenic on the magnesium hydroxide comprises structure selected from the group consisting of a recycle stream and extended piping.

23. A continuous water treatment system for reducing the concentration of arsenic in a flowing stream of water to below an acceptable level, comprising:

means for continuously adding magnesium hydroxide to the flowing stream of water;

means, fluidically connected downstream of the adding means, for continuously adsorbing arsenic on the magnesium hydroxide; and

means, fluidically connected downstream of the adsorbing means, for continuously separating and continuously removing from the flowing stream of water the magnesium hydroxide with adsorbed arsenic, thereby continuously reducing the concentration of arsenic in the water to below the acceptable level;

wherein the magnesium hydroxide has a median particle size less than 3 microns.

24. The system of claim 23, wherein the means for continuously separating and removing the magnesium hydroxide with adsorbed arsenic from the flowing stream of water comprises continuous separation means selected from the group consisting of settling means, skimming means, vacuuming means, draining means, dissolved air flotation means, vortex separating means, centrifuging means, magnetic separating means, and a combination of two or more of the foregoing.

25. The system of claim 23, wherein adding magnesium hydroxide to the water comprises adding magnesium oxide, which converts to magnesium hydroxide upon contact with the water.

26. The system of claim 23, wherein the means for continuously adding magnesium hydroxide to the flowing stream of water comprises an injector selected from the group consisting of a powder injector and a suspension injector.

27. The system of claim 23, wherein the separation means comprises settling means using a flocculating agent.

28. The system of claim 23, wherein the means for continuously adsorbing arsenic on the magnesium hydroxide comprises a holding tank to provide sufficient time for magnesium hydroxide to adsorb an amount of arsenic sufficient to reduce the concentration of arsenic in water below the acceptable level.

29. The system of claim 23; wherein the magnesium hydroxide is disposed on the surface of a carrier particle.

30. The system of claim 29, wherein the carrier particle is lighter than water.

31. The system of claim 30, wherein the carrier particle comprises a particle selected from the group consisting of a plastic microsphere and a polystyrene microsphere.

32. The system of claim 29, wherein the carrier particle is heavier than water.

33. The system of claim 32, wherein the carrier particle comprises a particle selected from the group consisting of a sand particle and a glass microsphere.

34. The system of claim 29, wherein the carrier particle is magnetic.

35. The system of claim 34, wherein said continuous separation means comprises means for magnetically separating the magnetic carrier particle from the water.

36. The system of claim 23, further comprising means for continuously adjusting the pH of the water, fluidically connected downstream of the means for after continuously separating and removing the magnesium hydroxide with adsorbed arsenic from the water.

37. A water treatment system for reducing the concentration of arsenic in water below an acceptable level, wherein the water comprises carbonate, the system comprising:

means for adding magnesium hydroxide to the water;

means, fluidically connected downstream of the adding means, for adsorbing arsenic on the magnesium hydroxide; and

means, fluidically connected downstream of the adsorbing means, for separating and removing from the water the magnesium hydroxide with adsorbed arsenic, thereby reducing the concentration of arsenic in the water to below the acceptable level;

wherein the $Mg(OH)_2$ is permitted to adsorb arsenic for a predetermined period of time; and

wherein the predetermined period of time is sufficiently long to allow a sufficient amount of arsenic to adsorb to $Mg(OH)_2$; and further

wherein the predetermined period of time is sufficiently short to prevent significant release of previously adsorbed arsenic on the $Mg(OH)_2$, due to conversion of $Mg(OH)_2$ to $MgCO_3$ by the carbonate in the water.

38. The system of claim 37, wherein the means for adding magnesium hydroxide to the water is operatively associated with a means for water softening that removes carbonate from the water by adding a compound that causes precipitation of $CaCO_3$ from the water.

39. The system of claim 37, wherein the means for adsorbing arsenic on the magnesium hydroxide comprises means for increasing the pH level to decrease the rate of formation of $MgCO_3$.

40. The system of claim 37, further comprising means for adding an inhibitor to the water comprising carbonate to inhibit conversion of magnesium hydroxide to magnesium carbonate.

41. The system of claim 40, wherein the inhibitor comprises a reagent selected from the group consisting of CaO and NaOH.

42. The system of claim 40, wherein the inhibitor increases the pH of the water.

43. The system of claim 37, wherein adding magnesium hydroxide to the water comprises adding magnesium oxide, which converts to magnesium hydroxide upon contact with the water.

44. A continuous water treatment system for reducing the concentration of arsenic in water to below an acceptable level and for recycling magnesium, comprising:

means for continuously adding magnesium hydroxide to the water;

means, fluidically connected downstream of the adding means, for continuously adsorbing arsenic on the magnesium hydroxide;

means, fluidically connected downstream of the adsorbing means, for continuously separating and removing from the water the magnesium hydroxide with adsorbed arsenic, thereby reducing the concentration of arsenic in the water to below an acceptable level, and whereby an aqueous solution comprising the removed magnesium hydroxide with adsorbed arsenic is continuously produced;

means, fluidically connected downstream of the means for separating and removing from the water the magnesium hydroxide with adsorbed arsenic, for continuously converting the magnesium hydroxide with adsorbed arsenic to magnesium carbonate, whereupon free arsenic is released into the aqueous solution;

means, fluidically connected downstream of the converting means, for continuously separating and removing the magnesium carbonate from the aqueous solution;

means, fluidically connected downstream of the means for separating and removing the magnesium carbonate from the aqueous solution, for heating the magnesium carbonate to produce carbon dioxide and purified magnesium oxide; and

means, fluidically connected downstream of the heating means, for providing the purified magnesium oxide to the means for continuously adding magnesium oxide to the water.

45. The system of claim 44, wherein the means for converting the magnesium hydroxide with adsorbed arsenic to magnesium carbonate comprises means for contacting the magnesium hydroxide with an aqueous solution comprising a reagent selected from the group consisting of sodium carbonate, sodium bicarbonate, potassium carbonate and potassium bicarbonate.

46. The system of claim 44, wherein the magnesium carbonate is heated to at least about 400 C.

47. The system of claim 44, further comprising means for converting the produced magnesium oxide to a powder of a desired size.

48. The system of claim 47, wherein the means for converting the produced magnesium oxide to a powder of a desired size comprises a milling station.

49. The system of claim 47, wherein the desired size is less than or equal to approximately 3 microns.

50. The system of claim 49, wherein the desired size is less than or equal to 0.5-1 microns.

51. The system of claim 44, further comprising means for removing arsenic from the solution comprising free arsenic, whereby purified arsenic is produced.

52. The system of claim 44, wherein the means for continuously adsorbing arsenic on the magnesium hydroxide comprises a holding tank to provide sufficient time for magnesium hydroxide to adsorb a sufficient amount of arsenic to reduce the concentration of arsenic in water below the acceptable level.

53. The system of claim 44, wherein the means for continuously separating and removing the magnesium hydroxide with adsorbed arsenic from the flowing stream of water comprises continuous separation means selected from the group consisting of settling means, skimming means, vacuuming means, draining means, dissolved air flotation means, vortex separating means, centrifuging means, magnetic separating means, and a combination of two or more of the foregoing.

54. The system of claim 44, wherein adding magnesium hydroxide to the water comprises adding magnesium oxide, which converts to magnesium hydroxide upon contact with the water.

55. The system of claim 44, wherein the means for continuously adding magnesium hydroxide to the flowing stream of water comprises an injector selected from the group consisting of a powder injector and a suspension injector.

56. The system of claim 44, wherein adding magnesium hydroxide to the water comprises adding magnesium oxide, which converts to magnesium hydroxide upon contact with the water.

57. A system for concentrating arsenic from a sample of water contaminated with arsenic, comprising:

means for adding magnesium hydroxide to a first sample of the arsenic contaminated water;

means for adsorbing arsenic on the magnesium hydroxide;

means for separating and removing from the first sample the magnesium hydroxide with adsorbed arsenic;

means for adding the removed magnesium hydroxide with adsorbed arsenic to a second sample of water, wherein the volume of liquid in the second sample is substantially less than the volume of liquid in the first sample; and

means for converting the magnesium hydroxide with adsorbed arsenic in the second sample to magnesium carbonate, whereupon free arsenic is released into solution; whereby the concentration of free arsenic in the second sample is concentrated relative to the first sample by the ratio of the volume of liquid in the first sample divided by the volume of liquid in the second sample.

58. The system of claim 57, wherein the ratio of the volume of liquid in the first sample divided by the volume of liquid in the second sample is greater than or equal to 10.

59. The system of claim 57, further comprising means for measuring the concentration of arsenic in the second sample, and means for dividing by the ratio of the volume of liquid in the first sample divided by the volume of liquid in the second sample, to produce the true concentration of arsenic in the first sample.

60. The system of claim 59, wherein the means for measuring the concentration of arsenic in the second sample comprises an ion-coupled plasma mass spectrometer

61. The system of claim 57, wherein the means for converting the magnesium hydroxide with adsorbed arsenic in the second sample to magnesium carbonate comprises means for adding to the second sample a carbonate reagent selected from the group consisting of sodium carbonate, sodium bicarbonate, potassium carbonate and potassium bicarbonate.

62. The system of claim 57, wherein adding magnesium hydroxide to the water comprises adding magnesium oxide, which converts to magnesium hydroxide upon contact with the water.

63. The system of claim 57, wherein the second sample of water has essentially no arsenic.

64. The system of claim 57, wherein the water in the second sample of water is distilled water.

65. The system of claim 64, wherein the first sample of water comprises at least one impurity other than arsenic, and wherein the at least one impurity from the first sample is not transferred to the second sample of water.